

# **Introducing Embedded Systems and the Microcontrollers**

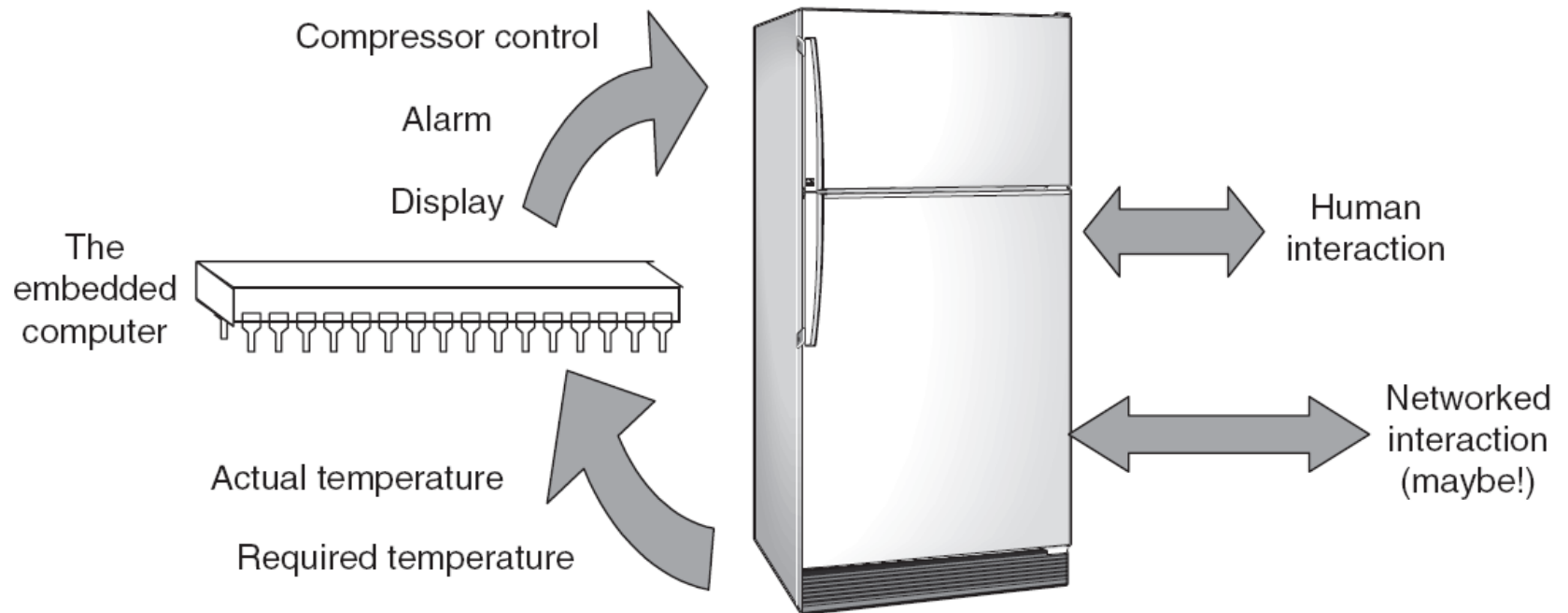
# Outline

- Definition of Embedded Systems
- Examples
- Computer Essentials
- Microprocessors and Microcontrollers
- PIC Microcontrollers
- 12 Series PIC

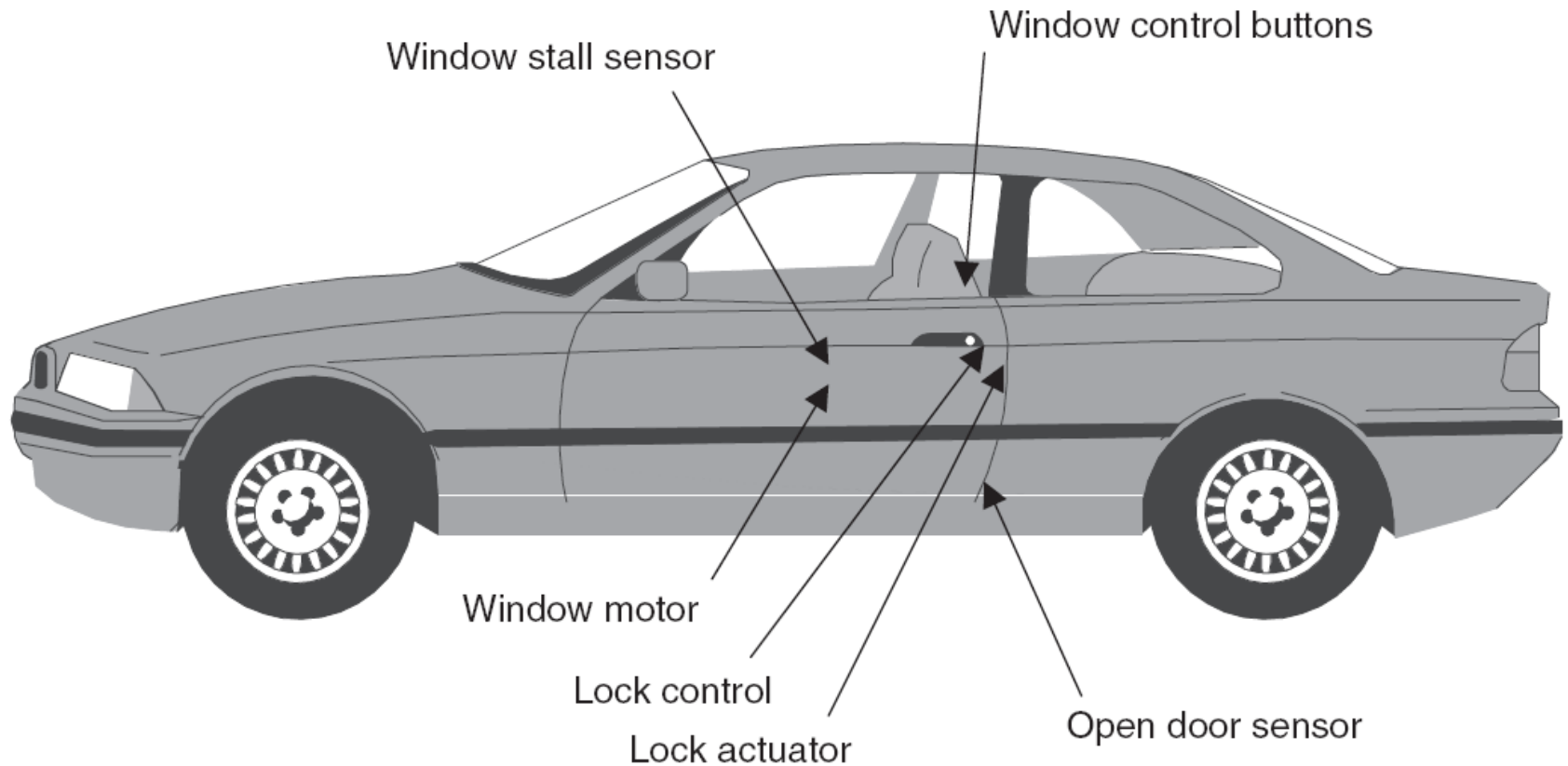
# Definition of Embedded Systems

- **Embedded system:** is a system whose principal function is not computational, but which is controlled by a computer embedded within it.

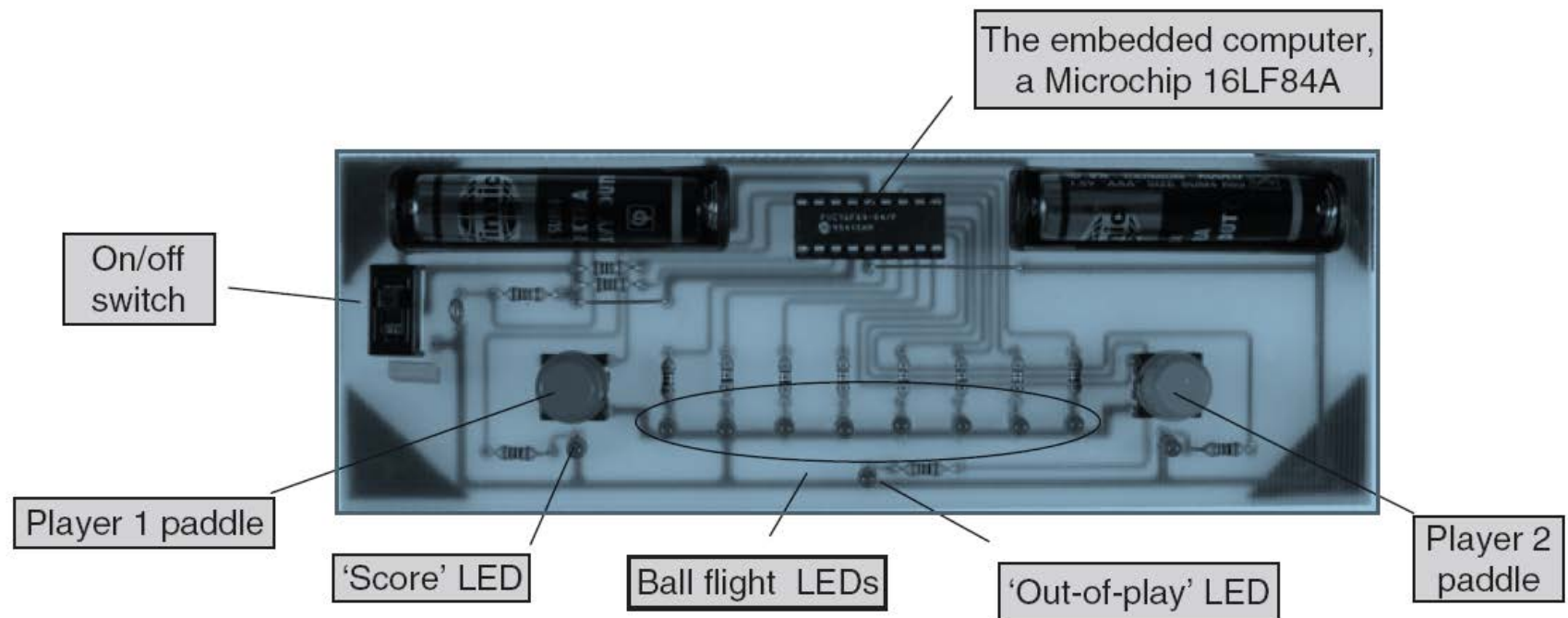
# Examples: Refrigerator



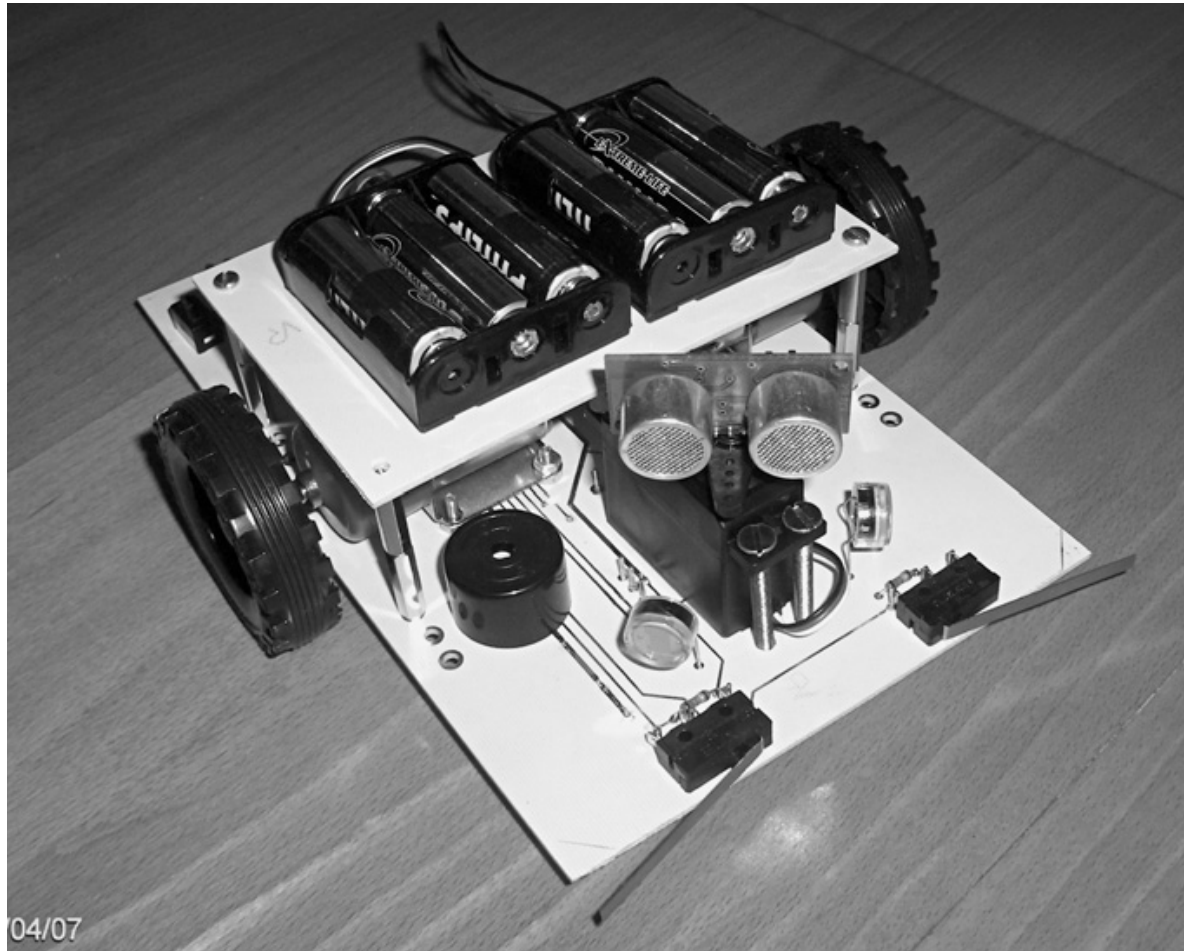
# Examples: Car Door



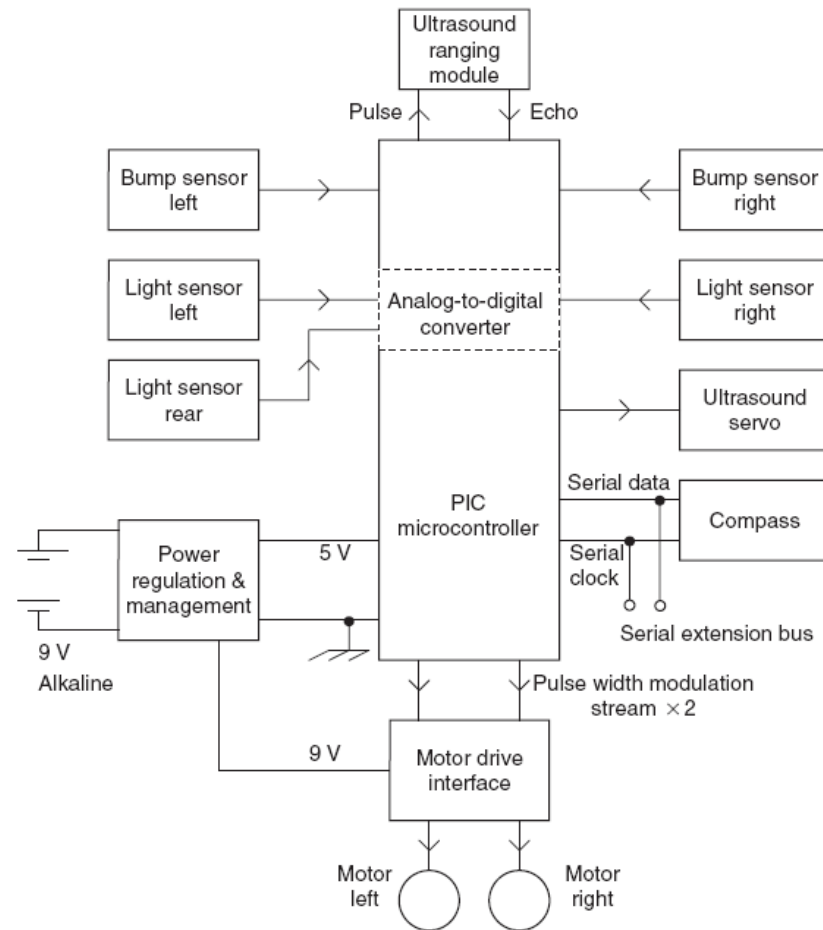
# Examples: Electronic Ping-pong



# Examples: Derbot Autonomous Guided Vehicle



# Examples: Derbot Autonomous Guided Vehicle

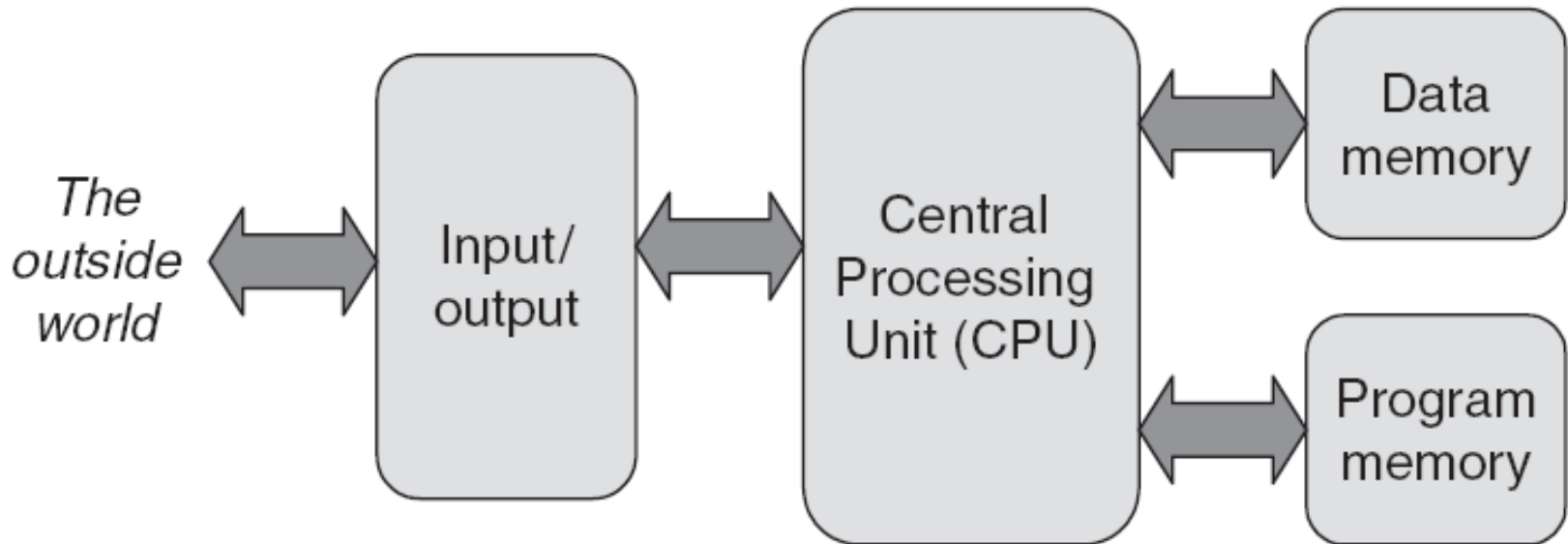




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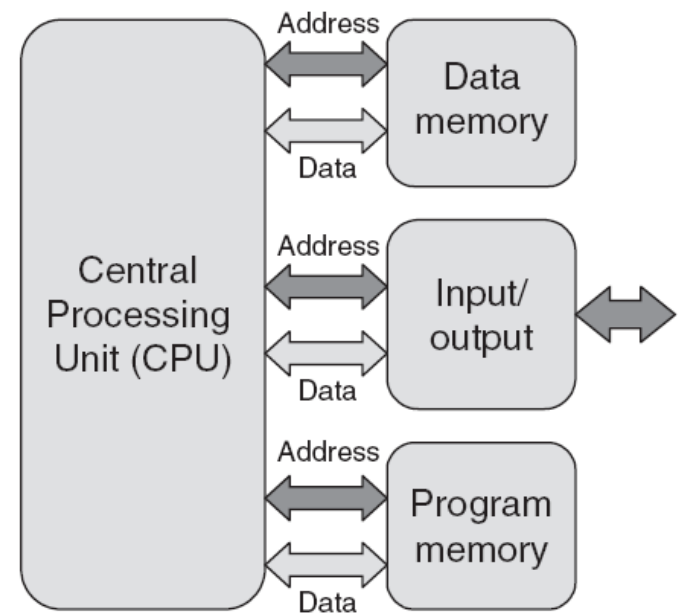
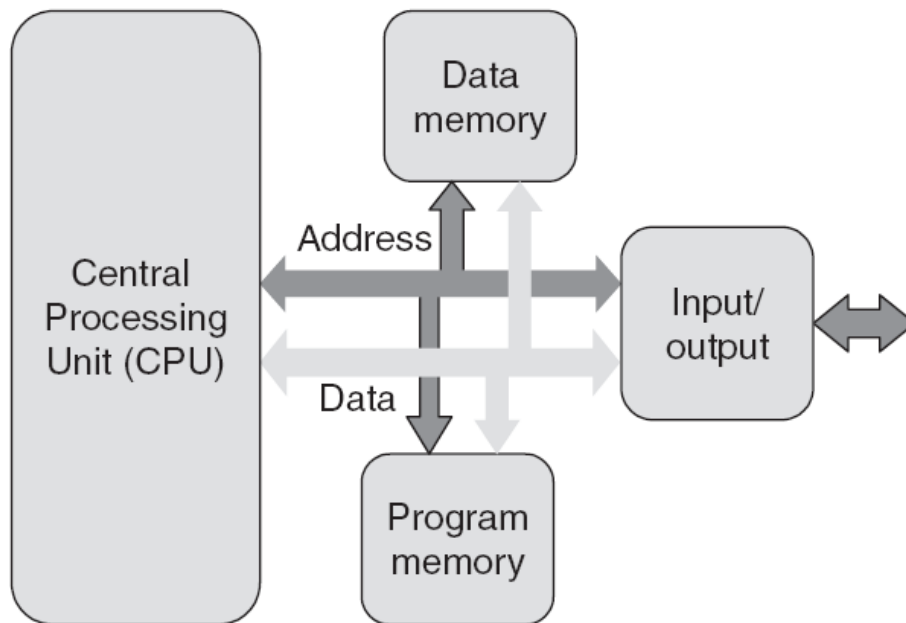
# Computer Essentials



# Computer Essentials

- Instruction Sets
  - CISC: Complex Instruction Set Computer
  - RISC: Reduced Instruction Set Computer
- Memory Types
  - Volatile: Random Access Memory (RAM)
  - Non-volatile: Read Only Memory (ROM)

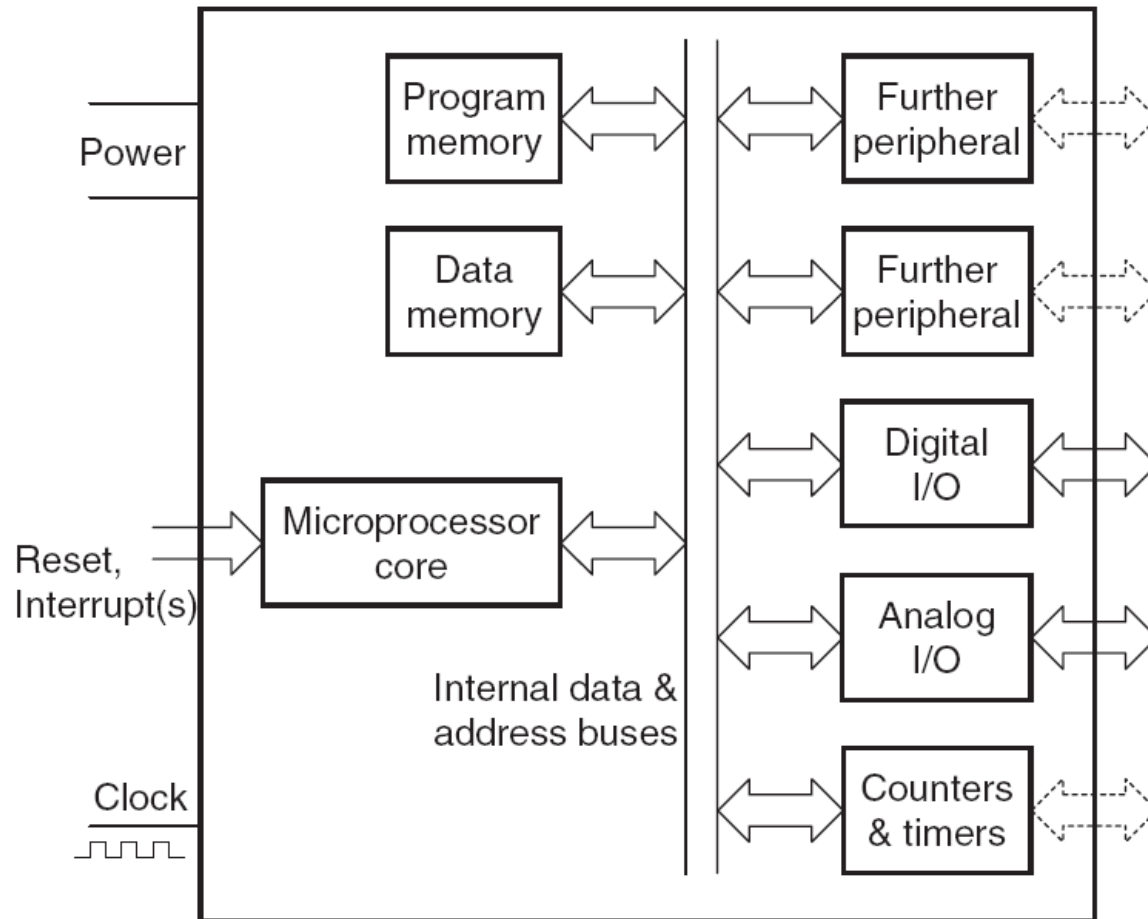
# Von Neumann and Harvard Computers



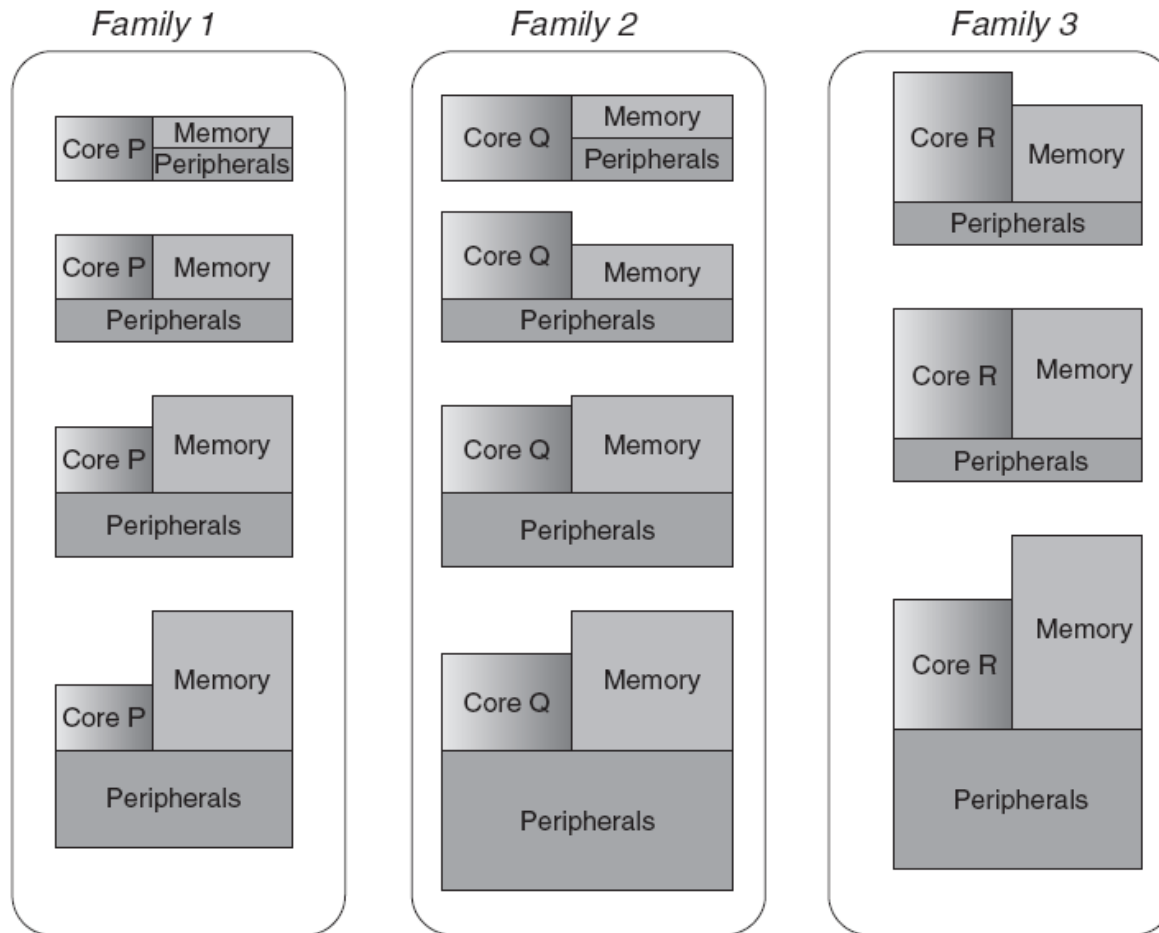
# Microprocessors and Microcontrollers

- The microprocessor is a processor on one silicon chip.
- The microcontrollers are used in embedded computing.
- The microcontroller is a microprocessor with added circuitry.

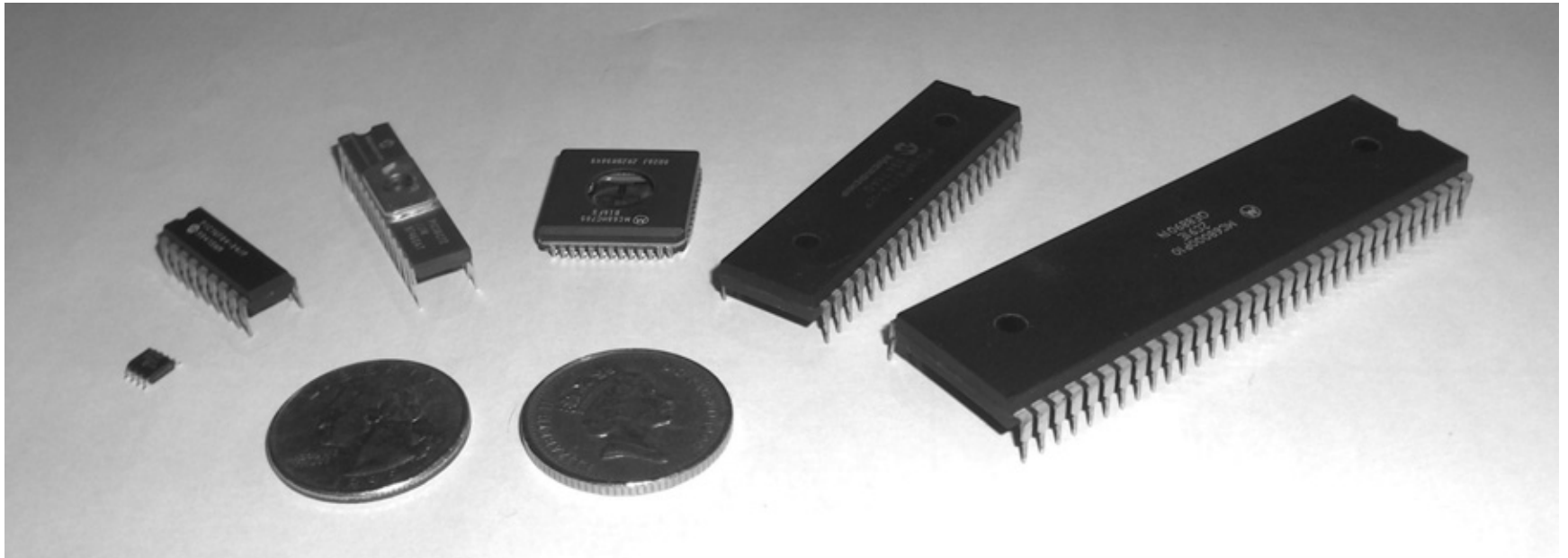
# Microcontrollers



# Microcontroller Families



# Microcontroller Packaging and Appearance



From left to right: PIC 12F508, PIC 16F84A, PIC 16C72, Motorola 68HC05B16, PIC 16F877, Motorola 68000



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# PIC Microcontrollers

- Peripheral Interface Controller (PIC) was originally designed by General Instruments
- In the late 1970s, GI introduced PIC<sup>®</sup> 1650 and 1655 – RISC with 30 instructions.
- PIC was sold to Microchip
- Features: low-cost, self-contained, 8-bit, Harvard structure, pipelined, RISC, single accumulator, with fixed reset and interrupt vectors.

# PIC Families

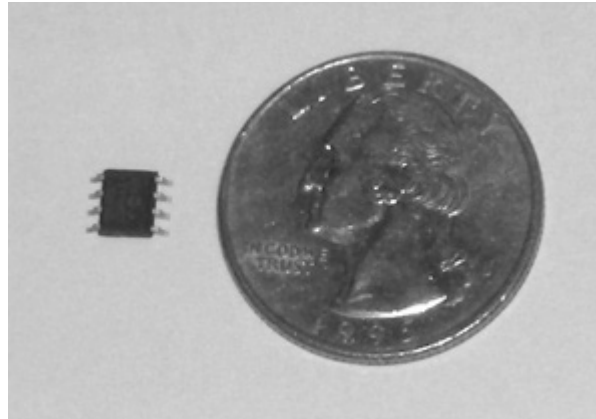
PIC Family	Stack Size	Instruction Word Size	No of Instructions	Interrupt Vectors
12CX/12FX	2	12- or 14-bit	33	None
16C5X/16F5X	2	12-bit	33	None
16CX/16FX	8	14-bit	35	1
17CX	16	16-bit	58	4
18CX/18FX	32	16-bit	75	2

‘C’ implies CMOS technology; Complementary Metal Oxide Semiconductor

‘F’ insert indicates incorporation of Flash memory technology

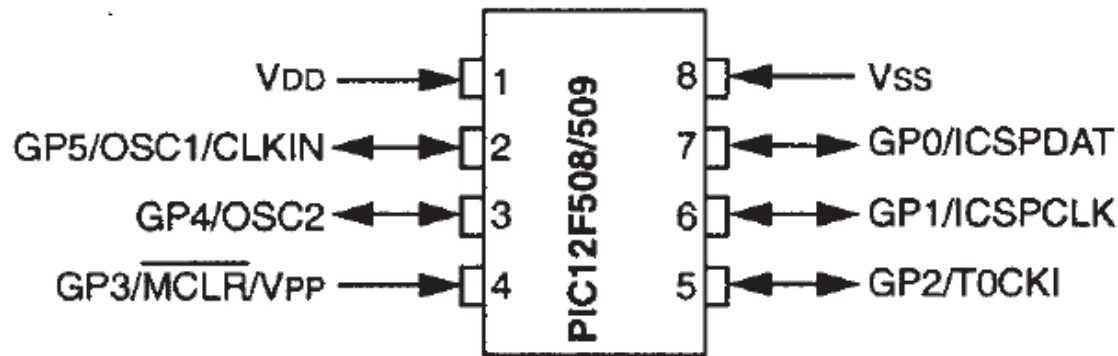
Example: 16C84 was the first of its kind. It was later reissued as the 16F84, incorporating Flash memory technology. It was then reissued as 16F84A.

# 12 Series PIC



The small 12F508

# PIC 12F508/509 pin connection diagram



## Key

$V_{DD}$ :

Power supply

$V_{PP}$ :

Programming voltage input

$V_{SS}$ :

Ground

OSC1, OSC2:

Oscillator pins

MCLR:

Master clear

GP0 to GP5:

General-Purpose input/output pins (bidirectional except GP3)

CLKIN:

External clock input

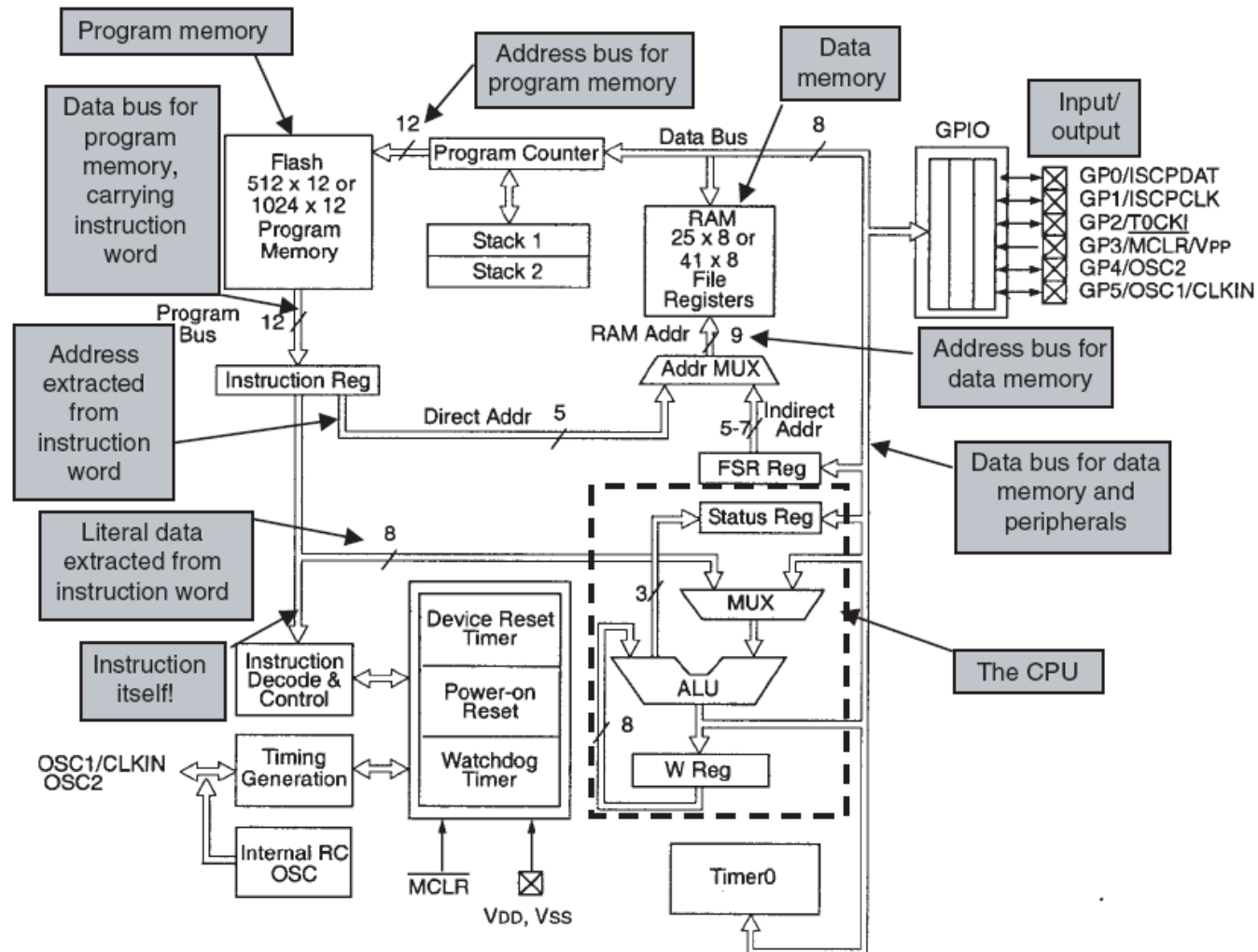
CSPDAT:

In-Circuit Serial Programming™ data pin.

CSPCLK:

In-Circuit Serial Programming™ clock pin.

# The 12F508 Architecture



# Summary

- An embedded system is a product that has one or more computers embedded within it, which exercise primarily a control function.
- The embedded computer is usually a microcontroller: a microprocessor adapted for embedded control applications.
- Microcontrollers are designed according to accepted electronic and computer principles, and are fundamentally made up of microprocessor core, memory and peripherals.
- Microchip offers a wide range of microcontrollers, divided into a number of different families. Each family has identical central architecture and instruction set. However, common features also appear across all their microcontrollers.
- The Microchip 12F508 is a good microcontroller to introduce a range of features of microcontrollers in general and of PIC microcontrollers in particular.